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INSTITUTE OF GAS TECHNOLOGY

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GAS ABSTRACTS

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1. GAS INDUSTRY

Federal Regulation

Kuykendall, J. K. NARUC DISCUSSES A LEADING QUESTION: IS FEDERAL PRICE REGULATION OF INDEPENDENT NATURAL GAS PRODUCERS IN THE PUBLIC INTEREST? *Gas Age*, **116**, 13 (1955) December 1.

The practical question is not whether the producers' prices should be regulated but how.

Author's Abstract

Swain, P. THE CASE AGAINST THE HARRIS BILL. *Oil Gas J.*, **54**, 42-44 (1955) December 19.

A report of an interview with the president of Brooklyn Union Gas Company, John Heyke, in which the gas distribution companies' view of the Harris Bill is presented. It is Mr. Heyke's position that the Harris Bill is contrary to the spirit of the Natural Gas Act and the Phillips decision, that regulation is not necessarily contrary to free enterprise and that the operation of escalator clauses and similar contract requirements condoned by the bill are contrary to free enterprise. R. F. Bukacek

Foreign Gas Industry

Laurien, H. and Sgelken, L. DIE ENTWICKLUNG DER GASWIRTSCHAFT IM BUNDESGEBIET 1954 (DEVELOPMENT OF THE GAS ECONOMY IN FEDERAL GERMANY 1954). *Gas- und Wasserfach*, **96**, 693-714 (1955) November 1.

This is the second detailed annual report on the general fuel gas economy in Western Germany. Total domestic and industrial gas supply is treated, with breakdowns for the coke-oven gas and the local gas industries. An increase is reported from 34.20 (in 1953) to 34.98 billion cu meters (1,197 to 1,224 billion CF) (which includes producer and blast-furnace gases). Appendixes give 42 tables and 26 graphs, which also review the annual data back to 1945. O. P. Brysch

Shimomoura, A. THE GAS INDUSTRY IN JAPAN. *Coke and Gas* (British), **17**, 429-37 (1955) November.

The history of the Japanese gas industry and its present position is reviewed. There are 75 gas works with varying capacities producing nearly 1,900 million cu ft of 405 Btu/CF gas, and consuming nearly 4 million tons of coal. About 59% of the total production is utilized for domestic purposes while industrial and commercial uses absorb 33%. The legislation and taxation governing the gas industries are discussed, as well as future trends in the Japanese gas industry. K. C. Channabasappa

Future Gas Supply

Green, S. WANTED: SUPPLEMENTARY PIPE LINE GAS. *Gas Age*, **116**, 36, 37, 58, 59 (1955) December 15.

After a review of the question of reserves and future fuel supply the author discusses recent and current research on production of supplementary pipeline gas. Residuum oil, shale oil and coal as the raw materials for gas, and possible coal processes, — 1) oxygen gasification with methane synthesis and 2) destructive hydrogenation to methane, are outlined from the standpoint of PAR research at Battelle Institute, Institute of Gas Technology and Bureau of Mines. The author urges constructive study of available results by the industry to clarify its objective, so that development can soon begin on a program leading to a technically feasible and reasonably economic process.

O. P. Brysch

2. APPLIANCES

Absorption Refrigerator

Grubb, G. A. (assigned to Aktiebolaget Elektrolux) ABSORPTION REFRIGERATOR OF THE INERT GAS TYPE. U. S. 2,728,201 (1955) December 27.

In an inert gas refrigeration (Platen-Munters type) system, evaporators at different temperatures are provided. A freezing compartment is provided with a low-temperature coil disposed horizontally while a higher temperature evaporator is situated above. J. F. Reed

Grubb, G. A. (assigned to Aktiebolaget Elektrolux) INERT GAS ABSORPTION REFRIGERATOR. U. S. 2,728,202 (1955) December 27.

Two evaporators are disposed at essentially the same level in a refrigerator of the inert gas

(Platen-Munters) type. The freezer and air cooling surface extend the width of the interior. J. F. Reed

Appliance Sales, 1955

Rockwell, W. F., Jr. GAMA SEES ANOTHER RECORD YEAR. *Amer. Gas Assoc. Monthly*, 38, 7-8 (1956) January.

The president of Gas Appliance Manufacturers Association reports 1955 as the biggest year in history in gas appliance sales to its 29 million customers, and optimistically predicts an equal record for 1956. He estimates total shipments of gas-fired appliances as follows:

Appliance	*Units Shipped 1955*	*Percent Gain over 1954*
Domestic Ranges...	2,277,000	12.1
House Heating Units	1,145,000	20.8
Automatic Water Heaters.....	2,799,000	22.7
Clothes Dryers.....	300,000	—

O. P. Brysch

THE PATTERN DURING 1955. *Appliance Mfr.*, 4, 26, 27, 29 (1956) January.

The appliance industry as a whole totalled a record year of $7.5 billion sales in 1955. Principal items are compared:

Appliance:	*Units 1955*	*Units, Peak Year*
Gas Furnace	850,000	655,900 (1954)
Gas Conversion Burners.	205,000	400,000 (1946)
Gas Ranges	2,277,000	3,031,300 (1950)
Gas Water Heaters.....	2,799,000	2,364,500 (1950)
Gas Dryers	364,000	236,148 (1954)
Electric Ranges.....	1,600,000	1,350,000 (1954)
Electric Water Heaters..	900,000	800,000 (1954)
Electric Dryers	1,040,000	661,603 (1954)
Electric Refrigerators ...	4,025,000	3,600,000 (1954)
Electric Freezers	1,100,000	990,000 (1954)
Automatic Washers	3,060,000	2,352,800 (1954)
Conventional Washers ..	1,140,000	3,421,464 (1948)
Ironers	85,000	396,715 (1950)
Vacuum Cleaners	3,287,883	3,800,687 (1947)

O. P. Brysch

Dryers

Marshall, W. W. TO KEEP CLOTHES DRYERS THE WONDERFUL BOON THEY ARE INTENDED TO BE, OBEY THESE FIVE CRITICAL RULES. *Butane-Propane News*, 17, 28-29 (1955) December.

Utmost care in installation is only one requisite if the housewife's satisfaction with her newest major gas appliance is to be insured. Here are some warnings on potential trouble spots that must be given serious consideration.

Author's Abstract

Space Heating

Gralla, L. L. P. GAS PROVES ITSELF FAR SUPERIOR FOR ARMY FINANCE CENTER'S PERSONNEL. *Butane-Propane News*, 17, 56, 58 (1955) December.

When it came to the question of heating two housing projects, Allen and Kelley, architects and engineers in Indianapolis, debated on oil, coal and LP-gas. Coal could not be used as there were no facilities for delivering and storing it or removing ashes, and fuel oil would require many underground tanks installed at considerable expense. Because LP-gas can be piped in the gaseous state from bulk storage tanks, is far cleaner than coal, and is comparable to either fuel in price, it won in both installations. Author's Abstract

Konzo, S. WARM AIR HEATING. *Air Cond., Heatg and Ventilg*, 52, 104-126 (1955) October.

The article is centered upon the conventional warm-air furnace heating system, though many of the comments apply directly to non-conventional types, inasmuch as basic laws of heat transfer are involved. S. A. Weil

Water Heating

Reiter, F. M. SERVICE HOT WATER DESIGN FOR MULTI-STORY BUILDINGS. *Air Cond., Heatg and Ventilg*, 52, 80-94 (1955) December.

Intelligent design of service hot water systems for multi-story buildings is predicated on many factors. Factual information plus valuable graphs are presented to show how hot water demand may be computed for various applications and hours of the day, pipe sizes and heat losses determined. Included are helpful design tables. Author's Abstract

3. COMBUSTION AND INDUSTRIAL FURNACES

Air Pollution Surveys

Goedhard, N. BASIC STATISTICS OF THE LOS ANGELES AREA. Air Pollution Foundation, 1, No. 6, pp. 1-74 (1955) January.

This report discusses the topography of the Los Angeles Basin, transportation and fuel consumption, rubbish disposal, and natural gas consumption in the area. The work is mainly

statistical and gives the results of surveys to determine the quantity of products discharged to the air from various sources.

R. T. Ellington

Hitchcock, L. B. TRACER TESTS OF THE ACCURACY OF TRAJECTORIES COMPUTED FROM THE OBSERVED WINDS IN THE LOS ANGELES AREA. Air Pollution Foundation, 1, No. 7, pp. 1-59, Los Angeles (1955) April 1.

This report discusses tests made to determine the direction of air movement in the Los Angeles Basin and its meaning as regards diffusion of pollutants. R. T. Ellington

Stormont, D. H. LOS ANGELES REFINERS MOVE IN ON SMOG. *Oil Gas J.*, 54, 160-162, 164-169 (1955) November 14.

Los Angeles refiners have halved the amount of pollutants which they release to the atmosphere, even though they initially accounted for very little of the smog problem. Oil companies have spent about $27,500,000 in this work. An outline of steps taken and some technical details of the procedures are included.

Author's Abstract

Southwest Research Institute. FEASIBILITY OF CONTROL METHODS FOR AUTOMOBILE EXHAUST. Air Pollution Foundation, 1, No. 10, pp. 1-62 (1955) August.

The feasibility of controlling the smog producing potential of automobile exhaust by use of LP-gas for fuel, alcohol-gasoline blends for fuel, or use of Houdry catalyst converters is discussed. Possible methods of cleaning up exhaust gases by engine modification are also pointed out. R. T. Ellington

Southwest Research Institute. FIELD EVALUATION OF HOUDRY CATALYTIC EXHAUST CONVERTERS. Air Pollution Foundation, 1, No. 8, pp. 1-77 (1955) June.

This report discusses tests made at Southwest Research Institute on the ability of the Houdry catalystic converter to complete the combustion of automobile exhaust gases. R. T. Ellington

Cutting Fuels

PRODUCTION EXPERIENCE PROVES LPG SUPERIOR FOR METAL CUTTING AND BRAZING. *Butane-Propane News*, 17, 68, 70 (1955) November.

Industrial acetylene generators used to supply fuel for metal cutting and brazing are signals for the live-wire LPG dealer to undertake replacement with a propane tank. The acetylene generator requires frequent recharging and supervision—entails considerable payroll cost for its operation. The propane tank is completely serviced by the dealer, with no payroll cost to the user. Metal cutting with propane costs less for fuel, less for oxygen, and less for cleanup following the cutting. Editor's Abstract

Flame Research

Burgwasser, H. and Pease, R. N. BURNING VELOCITIES OF HYDROGEN-AIR FLAMES. *J. Amer. Chem. Soc.*, 77, 5806-08 (1955) November 20.

The burning velocities of hydrogen air flames were determined from shadow graphs using a bunsen burner and a modification of the angle method. The results are higher than reported by other workers but a maximum at 42% hydrogen is in agreement with other investigations. Neither the thermal diffusivity nor the Tanford-Pease term Σ (p_i D_i) have maxima at this hydrogen concentration and it is therefore concluded that neither thermal nor diffusion theories can describe the results correctly.

S. A. Weil

Ferguson, R. E. ON THE ORIGIN OF THE ELECTRONICALLY EXCITED C_2 RADICAL IN HYDROCARBON FLAMES. *J. Chem. Phys.*, 23, 2085-89 (1955) November.

Mixtures of the isotopic acetylenes $HC^{12}C^{12}H$, $HC^{12}C^{13}H$, and $HC^{13}C^{13}H$ were prepared. Near-stoichiometric fuel-air flames were examined with respect to the spectrum of the C_2 radicals (Swan bands). The intensities of the band heads corresponding to the different isotopic forms of C_2 indicate that the distribution among $C^{12}C^{12}$, $C^{12}C^{13}$, $C^{13}C^{13}$ is that corresponding to random recombination of individual carbon atoms. It is concluded that the initial -C-C- bands in the fuel are broken prior to the appearance of the Swan bands. S. A. Weil

Simon, D. M. and Wagner, P. CHARACTERIZATION OF TURBULENT COMBUSTION

BY FLAME SPACE AND SPACE HEATING RATES. *Ind. Eng. Chem.*, 48, 129-33 (1956) January.

This study develops methods of measuring flame space rates (cc of gas flow/cc of flame zone-volume—sec.) and space heating rates (cal./cc flame zone volume—sec.) for turbulent flames. Experimental results for turbulent propane-oxygen-nitrogen pipe-burner flames stabilized by a small concentric pilot flame are given. Flame space rates and flame space heating rates are shown to be desirable parameters for turbulent flame characterization in theoretical and engineering applications. H. R. Linden

Engine-Generator

Malin, J. B. (assigned to The Texas Co.) ENGINE GENERATION OF SYNTHESIS GAS. U. S. 2,725,285 (1955) November 29.

This invention relates to the generation of hydrogen and carbon monoxide by the partial combustion of a gaseous hydrocarbon with an oxygen-containing gas in the combustion space of a cyclically operating internal combustion engine. The method of the present invention overcomes the uncertain operation of a combustion engine operated on a charge of hydrocarbon and concentrated oxygen to produce carbon monoxide and hydrogen, variously described as backfiring, preignition, and precombustion which is defined as combustion which occurs during the intake stroke.

Inventor's Abstract

Fuel Efficiencies

Duffy, T. H. "BOILER EFFICIENCIES": COAL, OIL AND GAS. *Coal-Heat* 69, 11-14, 17-19 (1955) December.

Data are presented on the efficiencies obtained by a number of relatively large boilers. When used with fuel prices and labor and maintenance savings possible with gas, this will assist in sales proposals. R. T. Ellington

Heat Treated Pipe

Kniveton, J. SHORT CYCLE HEAT TREATMENT IMPROVES LOW ALLOY PIPE PRODUCTION. *J. Metals*, 7, 1172-77 (1955) November.

Use of a short-cycle heat treating process has enabled the steel industry to produce oil field casing having 80,000 psi minimum yield strength from low-carbon and low-alloy steels. Key equipment is a cylindrical gas-fired furnace developed by Selas Corp. of America. The pipe is heated by radiation and convection by the duradient cup burners; no flame comes in contact with the pipe. First used on pipe in 1947, the process is now considered standard.

B. E. Eakin

Oil Gas Interchangeability

Searight, E. F., Linden, H. R., Nicol, D. L., and Pettyjohn, E. S. INTERCHANGEABILITY OF HIGH-BTU OIL GASES AND NATURAL GASES. Institute of Gas Technology (Chicago) Research Bull. 24 (1956) January ($5.00).

This Bulletin presents the results of a study of the performance of high-Btu oil gases of heating values in the 900-1700 Btu/SCF range when substituted for high-methane and high-inert natural gases on a group of five critical range burners, two refrigerator burners, and a group of thirteen critical and contemporary appliances. This substitution was made at three test conditions: 1) modification with a synthetic blast-blowrun gas (20% carbon dioxide—80% nitrogen) to the approximate heating value of the base gas; 2) modification with this inert gas to heating values and specific gravities that would maintain constant burner heat inputs, and 3) modification of typical high-Btu oil gases in the 1250 Btu/SCF heating value range with up to 27% of the above inert gases.

In both critical burner and appliance tests, yellow-tipping and flashback tendencies were determined over a range of primary aerations. In the appliance tests, carbon monoxide contents of the flue gases, pilot operation, and ignition times were also studied. H. R. Linden

Nuclear Power

Campbell, F. D. HOW IS ATOMIC ENERGY UTILIZATION LIKELY TO AFFECT THE INDUSTRIAL FUEL ECONOMY? *Gas*, 31, 47-50 (1955) November.

The author, Chairman of the AGA Atomic Energy Committee, foresees a gradual transition to nuclear energy with an expected squeeze on liquid fuels at about the year 1975. In another 100 years, atomic energy may have to supply about 60% of the total amount of energy consumed in this country. To explore the use of

atomic energy the gas industry through the gas operations research committee of the AGA has initiated a research project with the Institute of Gas Technology to study the production of natural gas substitutes from oil by use of radioactive substances. The Bureau of Mines is embarking on a research project involving the use of nuclear energy for the production of synthetic gas from coal. According to this author the gas industry should carry on moderate research in the uses of atomic energy and should concern itself with the development of technical manpower for carrying on this research.

E. J. Pyrcioch

Turbine Scale

Buckland, B. O. and Sanders, D. G. MODIFIED RESIDUAL FUEL FOR GAS TURBINES. *Amer. Soc. Mech. Eng. Trans.*, 77, 1199-1209 (1955) November.

Since sodium in gas turbine fuel causes rapid deposit formation and corrosion, it is removed by mixing with water and centrifuging. Turbine tests of 50 to 1500 hours duration show that use of such desalted fuels eliminates deposits if sodium and calcium are both kept below 10 ppm. E. B. Shultz

Submerged Combustion

Young, W. L., Douglas, C. J., Stengl, R. J., and Bedwell, F. B. (assigned to Ozark-Mahoning Co.) SUBMERSIBLE BURNER. U. S. 2,723,-659 (1955) November 15.

This is a submerged combustion burner designed to prevent the material being heated from having any portions overheated from contact with hot surfaces or gases. The burner surfaces are air-cooled and the combustion products diluted. R. T. Ellington

4. CARBONIZATION AND GASIFICATION

Char Retort

Lesher, C. E., Heights, B. A. (assigned to Lesher and Assoc., Inc.) LOW TEMPERATURE CARBONIZATION PROCESS. U. S. 2,723,226 (1955) November 8.

This invention relates to an improved process and apparatus for low temperature carbonization or distillation of carbonaceous materials, notably high volatile coking bituminous coals that became plastic during the process of distillation. The apparatus consists of a cylindrical, horizontal, rotating steel retort provided at one end with means for charging and at the other end with means for discharging volatile and solid products. The feed consisting of an admixture (1:3) of coking coal preheated to 600° F. and a non-coking, low-temperature char, or high-temperature coke breeze, preheated to 1000-1400° F., when fed continuously on to one end of the tumbling layer in the retort, results in an average temperature of 800-1000° F. for the material in the bed. The temperature of the shell of the retort is maintained at 50-100° F. higher. This method of supplying heat to the carbonaceous material is claimed at prevent the feed from contact with the shell of the retort and thus eliminates the formation of accretions on walls or other parts.

K. C. Channabasappa

Coal Gasification

Thompson, B. H. and Garside, J. I. INSTITUTION GAS RESEARCH FELLOWSHIP REPORT: 1953-54. THE FLUIDIZED GASIFICATION OF COAL. Inst. Gas Eng. (British) Publ. No. 474 (1955) November 22-23.

This Institution Gas Research Fellowship Report for 1953-54 deals with the development in the laboratory of a single-stage fluidized process for the continuous gasification of all types of coal fines, including those of caking coals, by mixing the coal with suitable inert materials. Results are given of the fundamental study to determine the range of gas velocities over which fluidization prevails and to determine the optimum size range for the inert material so as to reduce to a minimum the voidage of the fluidized bed. Following these results, a description is given of an experimental laboratory fluidized unit with a discussion of the results of its operation, batch and semi-continuous, for the gasification of coke and coals of varying caking properties in air and air-stream mixtures. The report concludes that the proposed process can be used for gasification of coke and non-caking coals, and for coals of moderate caking nature if mixed in suitable proportion with adequately sized inert material such as sand or calcined alumina. E. J. Pyrcioch

Coking Research

Peytavy, A. and Lahouste, J. UTILISATION DE LA RADIOGRAPHIE ET DE LA RADIOCINEMATOGRAPHIE POUR L'ETUDE DE LA COKEFACTION. (USE OF RADIOGRAPH AND RADIOCINEMATOGRAPHY FOR THE STUDY OF CARBONIZATION). Assoc Technique de L'Industrie du Gaz en France, 71, 415-22 (1954) June. (Paris)

The article describes the advantages of using radiography and radiocinematography techniques to study the physico-chemical changes that coking coals undergo in a laboratory carbonization furnace. Particular attention is paid to the study of structure and evolution of the upward-moving plastic region, visible as zones of varying opacity to the X-rays which penetrate the aluminum oxide sides of the coal container. The types of carbon produced and their appearance (the hot-face curvature and its relation to the coke-fissuring) and the nature of evolved volatile products are discussed.

K. C. Channabasappa

Dust Removal

Minet, R. G. (assigned to United Engineers and Constructors Inc.) PROCESS AND APPARATUS FOR THE REMOVAL OF FINELY DIVIDED SOLID CARBONACEOUS PARTICLES FROM FLUIDIZED CARBONIZERS. U. S. 2,723,951 (1955) November 15.

Cyclone separators are located within the carbonization and oxidation vessels of the process for the removal of dust from the product gases, with the less efficient removal system located in the oxidizer. For supplying process heat a cyclone burner is provided in which the off-gases from the oxidizer, with entrained carbonaceous particles, are burned.

E. J. Pyrcioch

Light Oil Recovery

Mantel, W. and Hansen, H. ZUSAMMENHAENGE UND NUTZANWENDUNG DER ERGEBNISSE AUS LABORATORIUM UND PRAXIS. 1. UEBER DIE GEWINNUNG DES ROHBENZOLS. (THE CONNECTIONS AND PRACTICAL APPLICATION OF RESULTS OF THE LABORATORY AND PRACTICE. I—THE RECOVERY OF CRUDE LIGHT OIL. *Brennstoff Chemie*, 36, 328-38 (1955) November 9.

The physical bases of mass transfer in countercurrent scrubbers are reviewed, and in the example of pure benzene/wash-oil the dependence of the absorption yield is expressed from the concentration of pure benzene in both phases, from the physical parameters of pressure, temperature and wash-oil molecular weight, and from the practical factors of oil circulation and number of transfer units or base number. The validity of Henry's Law for the partial pressure of the pure aromatics over their solution in wash-oils is inferred from published measurements of many authors, and confirmed by special measurements for the benzene homologs as well. Tabulated and graphical data, especially for various wash oils, is reviewed and discussed. O. P. Brysch

Methane Synthesis

Schlesinger, M. D., Demeter, J. J., and Murray, Greyson. CATALYST FOR PRODUCING METHANE FROM HYDROGEN AND CARBON MONOXIDE. *Ind. Eng. Chem.*, 48, 68-70 (1956) January.

Fixed and fluid bed laboratory data are given for converting of 3:1 H2-CO ration synthesis gas to methane over partially extracted 42% nickel—58% aluminum Raney catalyst. High space velocities have attained at high conversions and without the formation of excessive hot spots due to the highly exothermic reactions.

H. R. Linden

Mixed Gas

Mather, N. G. RECEIVING AND BLENDING OIL GAS. *National Gas Bull* (Australia), 19, 11-14 (1955) December.

Under the terms of a contract with another company, The Australian Gas Light Co. is to purchase oil gas from an external source into its manufacturing station at Mortlake. The gas at present being manufactured at this centre is a varying blend of coal gas, carburetted water gas and straight oil gas, with a declared calorific value of 511.8 Btu/CF. The oil gas to purchased will have, initially, a calorific value of 1,100 Btu per cubic foot. This value may be varied, in the future, down to 900 Btu/CF after suitable notice under the con-

tract. The oil gas is required to be free from impurities and will represent a considerable percentage of the thermal content of the final blended gas to be issued to the public. It is proposed that this final blend will have a declared calorific value of 555 Btu/CF. The problems associated with its receipt will include: 1) Receipt into the system. (Measurement of its thermal content and control of pressure. 2) Handling and blending. 3) Control of combustion characteristics of the final mixture of gases. 4) Fine control of the calorific value of the final mixture. These problems and The Australian Gas Light Co.'s answers to these problems are presented in the first two papers.

H. A. Dirksen

Oil Gas

THE YORK SEGAS PLANT. *Coke and Gas* (British), **17**, 461-65 (1955) December; *Gas J.* (British), 284, 531, 32 (1955) November 23.
The North Eastern Gas Board's new Segas plant at York is described and illustrated. Operating data and experience from the past year is discussed. About 900 to 950 MCF/day of 450 to 500 Btu gas is made from heavy fuel oil (950 sec. Red. No. 1 at 100° F.) with the 3-shell, lime-magnesite catalyst plant.

O. P. Brysch

5. NATURAL GAS AND NATURAL GAS CONDENSATES

Compressors

Caldwell, J. H. HOW TO SELECT A LUBRICANT FOR A COMPRESSOR AND TO EVALUATE ITS PERFORMANCE. *Gas*, **31**, 91-95 (1955) December.
The author reviews the causes and evidence of lubrication difficulties, and presents various guides to attainment of proper lubrication.

R. F. Bukacek

Kehres, J. W. WIDE RANGES IN DEMAND ON RECIPROCATING COMPRESSORS MET WITH DOUBLE DECK VALVE. *Gas*, **31**, 96-97 (1955) December.
A brief discussion of the use of double-deck valves in gas compression. Their advantages are reduced work loss, and the possibility of placing clearance pockets on the crank ends of double-acting compressor cylinders.

R. F. Bukacek

Moerke, N. H. and Newman, C. HOW TO CONTROL PIPING SYSTEM PULSATIONS. *Pipe Line Ind.*, **3**, 44-45 (1955) December.

It is difficult to predict the exact magnitude of pulsations in gas piping systems before a station goes into operation. But the problems can be minimized through the diligent use of the dynamic relationships in the design of compressor plant piping and pulsation dampening equipment. This article offers a summary of pulsation dampening engineering today.

Authors' Abstract

Conditioning

Kohl, A. L. and Riesenfeld, F. C. GAS CONDITIONING TODAY. PART I: PARTICULATE MATTER REMOVAL AND GAS PURIFICATION. *Petroleum Refiner*, **34**, 209-13 (1955) November.

Part 1 of a 2 part series on the current problems in gas conditioning and how they are being solved.

R. F. Bukacek

Cost of Gas

McConnell, E. J. THE UTILITY MAN'S $64,000 QUESTION, WHAT ABOUT SUPPLY AND COSTS? *Gas Age*, **116**, 38, 39, 42, 43, 78 (1955) November 17.

Because of rises in the cost of purchased natural gas, labor and material costs, plant investment and taxes, the utility managements should plan very carefully on any load development. Spread between cost of coal and oil and that of gas has narrowed, and electricity has become heavily competitive in domestic and small industrial uses. The form of future regulation has produced wide uncertainty among utilities except on the fact of increased future costs. Fuel prices, operating expenses and construction costs are tabulated and analyzed to show this trend.

O. P. Brysch

Drilling

Bobo, R. A., Hoch, R. S., and Ormsby, G. S. AERATED MUD DRILLING. *Petroleum Eng.*, **27**, B46, 49, 51 (1955) November.

The latest equipment, procedures, and operating techniques involved in using aerated drilling muds are discussed. A schematic diagram of equipment and flow system is presented.

B. E. Eakin

McLaurin, J. H. and Ford, F., Jr. NEW HIGH WEIGHT MUD SAVES RIG TIME. *Petroleum Eng.*, 27, B83-85 (1955) December.

The new CMC-bentonite drilling mud system has found considerable favor in the deep drilling in Southern Louisiana. This system features faster mixing, better stability at high temperatures, and lower cost than lime muds, and offers better completion characteristics.

B. E. Eakin

Polumbus, E. A., Jr. and Legge, M. S. 3876 FEET PER BIT WITH AIR. *World Oil*, 141, 144, 146, 148, 150 (1955) December.

A comparison is presented of the drilling time and net rotating time for three wells drilled in the Powder River Basin, Wyoming. The first well was drilled using conventional mud as drilling fluid. Wells 2 and 3 were drilled using air as the circulating medium. The results obtained indicate considerable savings effected by the use of air. B. E. Eakin

Flow Control

Foulke, G. REMOTE CONTROL OF GAS FLOW AT DELIVERY MEASURING STATIONS. *Petroleum Eng.*, 27, D22-23 (1955) December.

A brief description of the remotely operated flow controllers recently installed by Gulf Interstate at three Kentucky metering stations.

R. F. Bukacek

Fracturing

Young, V. R. APPLICATION OF HYDRAULIC FRACTURING TO CALIFORNIA FORMATIONS. *Calif. Oil World*, 48, 1, 4, 6-9, 1st issue (1955) November.

California sediments were considered unsuitable for the new fracturing techniques, at first, but the yearly rate of successful well fracturing jobs is steadily increasing. The thick pays behave abnormally when subjected to the high pressure and fluid injection. New procedures are resulting in the percentage of wells considered as economically successful approaching that of other areas. B. E. Eakin

Gas Injection

Whorton, L. P. and Brownscombe, E. R. (assigned to The Atlantic Refining Co.) METHOD OF RECOVERING DESIRABLE PETROLEUM HYDROCARBON FRACTIONS FROM PRODUCING OIL RESERVOIRS. U. S. 2,724,437 (1955) November 22.

This invention relates to a method of increasing the ultimate oil recovery from a reservoir by early injection of normally gaseous hydrocarbons. The gas injected is supposed to be dissolved in the oil in the reservoir.

B. E. Eakin

Gas Line Design

Arnold, M. L. PIPE SIZING METHODS FOR PLANT AND FIELD GAS LINES. *Petroleum Eng.*, 27, D13-18, 20 (1955) December; *Amer. Gas J.*, 183, 29-36 (1956) February.

Several graphical and computational methods for design of gas lines and compressor requirements are given. The article is of interest in that several rather unusual methods of treating the design equations are given.

R. F. Bukacek

Ford, S. D. HOW TO DESIGN A GAS PIPELINE. *Oil Gas J.*, 54, 106-07, 109-10 (1955) December 12.

The right size and weight of pipe and correct spacing of compressor stations — these are among the most important factors in good design. The author, chief engineer for Kansas-Nebraska Natural Gas Co., gives the steps in design computation and figuring economics for two different pipeline designs.

Author's Abstract

Gas Meters

FIELD TESTING AND REPAIR OF LARGE CAPACITY, P-D METERS. *Amer. Gas J.*, 182, 17-18 (1955) November.

Field testing of large capacity positive displacement meters is usually accomplished at the meter site. The meter is by-passed and a portable air blower connected to the meter. A standard orifice run is used to calibrate the meter. W. G. Bair

Serif, M. METERED SERVICE—ANSWER TO ELECTRIC UTILITY COMPETITION. *LP-Gas*, 5, 39-40 (1955) November.

The advantages of metered service for LP-gas customers are illustrated by the experience of

the Wisconsin Rapids Gas and Electric Co. with this type of service. It requires additional capital but its advantages make for better public relations, better service, and greater salability of LP-gas. G. G. Wilson

Gasoline Recovery

Banner, W. E. TWO-STAGE DISTILLATION AND TWO-STAGE REABSORBER. *Oil Gas J.*, 54, 85-86 (1955) December 12.

Some 167,000,000 cu. ft. per day of casing-head gas from the Spraberry Trend is processed by the Midkiff natural-gasoline plant. Main absorbers operate in the range of 695 to 825 psi. Two stages of reabsorption are provided and a two-still distillation system.

Author's Abstract

LP-Gas Sales

Benz, G. R., Tucker, P. W. and DeVoe, W. F. LP-GAS SALES UP SHARPLY: INCREASE LARGEST IN HISTORY. *Gas Heat*, 7, 42, 44 (1956) February; *Gas Age*, 117, 36, 37, 40, 72 (1956) January 12; *LP-Gas* 16, 110-13 (1956) February; *Butane Propane News*, 18, 48, 49, 52, 54, 56 (1956) January; *Oil Gas J.* 54, 52, 53 (1956) Jan. 2; *Amer. Gas Assoc. Monthly*, 38, 9, 10 (1956) January.

Careful estimates indicate that marketed production of LP-gas has increased in 1955 by 17.2% over the 1954 record high, to reach a total 6,006 million gallons. Uses were: domestic and motor fuel, 3,661 million; miscellaneous industrial, 431; gas mfg., 171; chemical mfg., 1,262; rubber mfg., 481 million gallons. Between 6500 and 7000 bulk plants, 22 new producing plants, and increased underground storage to total 602.7 million gallons were in existence by the end of 1955. O. P. Brysch

Main Repairs

I. G. E. Pipes Committee. RECOMMENDATIONS TO PREVENT ACCIDENTS DURING THE CUTTING OUT OF GAS MAINS FOR REPAIRS AND ALTERATIONS. Instn. Gas Eng. (British) Publn. No. 473 (1955) November.

A set of recommendations in regard to the planning, equipment, and labor necessary to cut out sections of large-diameter gas pipelines quickly and safely. G. G. Wilson

Natural Gas Moisture

Bukacek, R. F. EQUILIBRIUM MOISTURE CONTENT OF NATURAL GASES. Institute of Gas Technology (Chicago) Research Bull. 8 (1955) November, $3.00)

This bulletin presents a description of laboratory equipment and experimental techniques, experimental measurements of the moisture contents of methane, propane, nitrogen, a methane-propane mixture, two methane-butane mixtures, a methane-pentane mixture and two natural gases, at 220° F. and in the pressure range 1000-10,000 pounds per square inch, and a newly developed correlation for computing the equilibrium moisture contents of natural gases. R. F. Bukacek

New Reservoir

McCaslin, J. C. NEW SOONER TREND STRETCHES 30 MILES. *Oil Gas J.*, 54, 127 (1955) December 19.

The Basal Pennsylvanian Sand oil and gas-distillate reservoir was discovered early in 1955. This discovery and a reworked hole drilled into the sand set off a promising drilling campaign that shows excellent prospects for 1956.

B. E. Eakin

Offshore Operations

Fritts, C. J. CORROSION CONTROL ON OFFSHORE DRILLING AND PRODUCING EQUIPMENT. *Corrosion*, 11, 471t-76 (1955) November.

A descriptions of methods used by one oil company to protect steel offshore drilling platforms and tenders and boats used in the offshore drilling operations. A 6-mil vinyl coating system is recommended for the parts of the drilling platform more than ten feet above the water line and cathodic protection is recommended for submerged areas. Several methods of protecting the splash zone are described and costs per square foot of protected surface are given for each method. G. G. Wilson

Williams, N. HERE'S LOUISIANA OFFSHORE TALLY FOR 1955. *Oil Gas J.*, 54, 153 (1955) November 28.

This year 23 new oil and gas fields were discovered on Louisiana's Continental Shelf Areas. The discoveries are tabulated. B. E. Eakin

TEXANS' $150-MILLION PROJECT FIRST MAJOR OFFSHORE LINES. *Oil Gas J.*, 54, 60 (1955) November 28.

A 364-mile 30-inch gas line paralleled by a 20-inch crude oil line have been proposed for gathering and transporting offshore production. The lines would start at the Texas side of the Sabine River near Port Arthur and extend south of Louisiana to the Mississippi side of the Pearl River. B. E. Eakin

Pipeline Operation

Beck, G. H. PIPELINE PATROL: HOW TO PROTECT VALVE-OPERATOR MOTORS. *Oil Gas J.*, 54, 105-06 (1955) December 19.

Here is a method that can be used to prevent burning out motor operators, based on consideration of electric-motor overload relays.

Author's Abstract

Deering, R. G. BOOSTER STATION GOES AUTOMATIC. *Oil Gas J.*, 54, 92, 93, 95 (1955) December 19.

Here is how Detroit Southern Pipe Line Company's automatic booster station at Flat Rock, Mich., is operated with both suction and discharge-valve control. This is a 77-mile, six-inch products line from Detroit to Toledo.

Author's Abstract

"MOLE" LOCATES PIPE. *Oil Gas J.*, 54, 50 (1955) November 28.

The Sperry-Sun Well Surveying Co's. latest electronic device for plotting the path of a submerged pipeline is discussed. The instrument can be run in any pipeline over 10 inches in diameter and will accurately record the position of the pipe as it moves through the line.

B. E. Eakin

Radioactive Tracers

Kohl, J., Newacheck, R. L. and Anderson, E. E. LOCATING CASING SHOE LEAKS WITH RADIOACTIVE ARGON. T. P. 4182. *J. Petroleum Techn.*, 7, 213-16 (1955) December.

Radioactive materials were used underground before the advent of the nuclear reactor. Radium-containing ores have been mixed with cements and other materials for later location in oil wells by gamma ray logging since 1940. Perforating bullets have been marked with radium salts, and radioactive materials have been added to drilling muds to find the cause of "lost circulation." More recently colloidal suspensions of radioactive cobalt-60 and silver-110 and solutions of iodine-131 have been used in waterflooding operations to determine injection profiles, flow paths and water velocities. In this paper a recent and interesting underground tracer application is discussed. Development work and field engineering was carried out under the direction of Tracerlab, Inc., with assistance from personnel of the client. A gaseous tracer, argon-41, was used in an attempt to determine the cause of leakage from an underground gas storage reservoir.

Authors' Abstract

Reservoir Engineering

Douglas, J., Jr., Peaceman, D. W., Rachford, H. H., Jr. CALCULATION OF UNSTEADY-STATE GAS FLOW WITHIN A SQUARE DRAIN AREA. *J. Petroleum Techn.*, 7, 190-95 (1955) November.

The problem of unsteady-state gas flow through porous media has been solved numerically only for the case of linear or radially symmetric reservoirs. A recently introduced numerical method for solving the unsteady-state heat flow equation in two dimensions is applied to the calculation of the depletion of a square region containing a perfect gas. Solutions are presented in graphical form for various values of dimensionless parameters. The solutions are compared with published solutions for radial reservoirs. Authors' Abstract

Matthews, C. S. and Lefkovits, H. C. STUDIES ON PRESSURE DISTRIBUTION IN BOUNDED RESERVOIRS AT STEADY STATE. T. P. 4164. *J. Petroleum Techn.*, 7, 182-89 (1955) November.

The purposes of this study are (a) to determine the accuracy of a previously proposed method for calculating average reservoir pressure and b) to find a method for estimating the shape of the drainage area of each well in a bounded reservoir. Both numerical and experimental methods are used to determine the pressure distribution and the location of drainage boundaries in idealized reservoirs at steady state. A number of photographs are included which show flowlines and drainage areas in reservoir models of various shapes. Results from these studies are then compared with those from the

previously proposed method for calculating average reservoir pressure. It is concluded that the previously proposed method is sufficiently accurate for most reservoir engineering purposes. In addition, some simple methods are given for estimation of shapes of drainage boundaries. Authors' Abstract

Moore, T. V. RESERVOIR ENGINEERING BEGINS SECOND 25 YEARS. Oil Gas J., 54, 148-151 (1955) November 21.

Some of the advances that have been made in the first 25 years since reservoir engineering became a science instead of an art are discussed, and a preview of what to expect from the industry in the future is sketched.

B. E. Eakin

Stahl, C. D. RESERVOIR ENGINEERING IN SECONDARY RECOVERY. PART I. DETERMINATION OF FIELD-EFFECTIVE PERMEABILITIES AND WELL RADII. *Producers Monthly*, 20, 20 (1955) November.

The equations for determining permeability and effective well radii are derived, and the limitations on their use discussed. B. E. Eakin

Station Design

Holmes, V. M. FUEL COST CHARTS FOR ENGINE SELECTION. *Pipe Line Ind.*, 3, 31 (1955) November.

Fuel consumption is perhaps the Number 1 consideration in selecting engines for pipe line use. Here is a good way to determine just which fuel would be best for a particular installation.

Author's Abstract

Robinson, H. ALASKAN LINE STATIONS DESIGNED FOR WEATHER EXTREMES. *Pipe Line Ind.*, 3, 24-27 (1955) November.

How would you design a station to handle fluid temperature variations from 42° F. to 102° F.? Then, think too, of operating temperature ranging from —80° F. to 100° F. Here is how these special design problems were solved on the Alaskan products line. Author's Abstract

Turner, E. B. HOW FAR HAVE WE COME IN PUMP STATION AUTOMATION? *Pipe Line Ind.*, 3, 32-34, 37, 38 (1955) November.

An industry-wide survey shows that oil pipe line companies are heading toward automation in a big way. This is especially true in new installations. A look at the present status of the industry, gives an idea of future trends.

Author's Abstract

Sulfur Recovery

Butler, J. R., Dew, J. E. and Zink, D. G. (assigned to Stanolind Oil and Gas Co.) METHOD FOR RECOVERING ELEMENTAL SULFUR FROM GASES. U. S. 2,724,641 (1955) November 22.

Submerged combustion of a gas containing H_2S is effected in a suitable liquid bath whereby the temperature of the reaction zone is maintained in a range such that SO_2 formation is minimized, high yields of elemental sulfur are obtained, and the need for subsequent treatment of the exit gases to recover additional quantities of sulfur is eliminated or greatly reduced. Liquid water is preferably used as the bath liquid. Normally the temperature of the bath is held above the melting point of sulfur and the sulfur produced is drawn off from the bottom of the bath. If preferred, a colloidal form of sulfur may be produced by operating the bath at temperatures below the melting point of sulfur. D. M. Mason

Well Practise

Rhodes, A. F. and Wilhoit, J. C. CRITERIA FOR CASING HEAD SLIP SUSPENSION. *Petroleum Eng.*, 27, B105-08 (1955) November.

The requirements for adequate slip installations are discussed. The various design variables and their limits are outlined and one method of controlling friction is presented.

B. E. Eakin

NEW IDEA IN OIL AND GAS WELL CEMENT. *Petroleum Eng.*, 27, B61-62, 64 (1955) December.

An aluminous material combined with inhibited phosphoric acid and a fluoride compound accelerator are the ingredients providing a new concept for cementing. The new material exhibits unusual bonding characteristics to steel casing and subsurface formations, will tolerate relatively high percentages of contamination and has a controllable setting time. Results of field applications to data have been very encouraging. B. E. Eakin

Weight Coating

Sterrett, E. NEW FLEXIBLE COATING FOR MARINE LINES. *Pipe Line News*, **27**, 37-40, 42 (1955) December.

A new method of weighting and protecting underwater pipelines is described. This method utilizes a new coating material, Timkote, composed of an asphalt base with barite weighting material which is applied by a special coating machine developed by the Southern Production Company. The coating is reported to be much tougher and more flexible than conventional concrete weighting coatings. The coating machine can be used in barge laying operations.

G. G. Wilson

6. PETROLEUM AND SYNTHETIC LIQUID FUELS

Catalyst Deposits

Hofer, L. J., Sterling, E. and McCartney, J. T. STRUCTURE OF THE CARBON DEPOSITED FROM CARBON MONOXIDE ON IRON, COBALT AND NICKEL. *J. Phys. Chem.*, **59**, 1153-55 (1955) November.

The structure of carbon deposits formed by the decomposition of carbon monoxide on iron, cobalt and nickel catalysts at 390° C. was studied with an electron microscope. These deposits were found to consist of filaments ranging from 0.01 to 0.2 microns in diameter. On iron the filaments are single strands; on nickel they are either tubular or bifilaments; and on cobalt either in the form of solid filaments and tubular or bifilaments. Electron micrographs of the deposits are included. E. J. Pyrcioch

Fluid Coke Fuel

Stracke, F. H. and Schiffer, F. H. FLUID COKE—NEW FUEL FOR THE STEAM INDUSTRY. *Oil Gas J.*, **54**, 75-78 (1955) November 28.

Laboratory and full-scale tests show that the steam industry has a fourth fuel, fluid coke, which can compete with coal, gas, and oil. Included are results of full-scale combustion tests at Essex station of Public Service Electric & Gas Co., Newark, N. J. Other tests are now under way at several installations, and the results should be available soon.

Authors' Abstract

Hydrogenation

Law, R. D. HYDROGENATING WYOMING BLACK OILS. *Petroleum Ref.*, **34**, 219-20 (1955) November.

The effect of high-pressure catalytic hydrogenation on Rocky Mountain black crude oils was studied. These oils, which contain large amounts of asphaltic cyclic and polycyclic compounds, have presented refining problems. Hydrogenation resulted in increased API gravity and greater percentages of low-boiling olefins and aromatics. A commercial nickel catalyst was used. E. B. Shultz

Shale Oil Distillation

Elliott, K. M. (assigned to Socony Mobil Oil Co.) SHALE RETORTING METHOD AND APPARATUS. U. S. 2,723,225 (1955) November 8.

This patent describes a four-zone vertical retort for continuous processing of crushed shale.

E. B. Shultz

Martin, H. Z., and Tyson, C. W. (assigned to Esso Research and Engineering Co.) FLUIDIZED DISTILLATION OF OIL-BEARING MINERALS. U. S. 2,725,348 (1955) November 29.

This patent describes a fluidized system for distillation of oil shale with a novel heat exchange method. An extraneous solid heat carrier (ceramic or metal balls which are heavier than the subdivided shale) is heated by direct contact with the spent shale and is passed downward in counter-current exchange with the shale which is fluidized within the interstices of the heat carrier. High thermal efficiencies are claimed. E. B. Shultz

Waste Disposal

Shea, R. C. and Hackathorn, J. HOW TO ELIMINATE H_2S ODORS. *Petroleum Refiner*, **34**, 191-93 (1955) November.

In cat cracker operating area, waste flue gases are used to strip H_2S from foul water before it reaches the sewer. Authors' Abstract

ANTI-POLLUTION LAW: THREAT TO OKLAHOMA OIL PRODUCERS. *World Oil*, **141**, 88-92 (1955) November.

A recently-enacted anti-pollution law threatens to bring about the abandonment of thousands of marginal wells in Oklahoma, particularly in

the Greater Seminole area. Here is a discussion of the operators' view point including the economics involved. This article should help operators understand the situation and may contribute toward a compromise with Oklahoma state regulatory bodies which will result in effective disposal of deleterious oil field wastes without abandoning thousands of wells.

Editor's Abstract

7. ANALYTICAL METHODS AND TESTS

Alkyl Phenols Method

Fair, F. V. and Friedrich, R. J. QUANTITATIVE INFRARED ANALYSIS OF ALKYL PHENOL MIXTURES. *Anal. Chem.*, 27, 1886-95 (1955) December.

A description is given of the method used for the determination of the quantitative amounts of phenol, the three isomeric xylenols, and several isomeric trimethylphenols in coal tar or tar acid oil. A recording infrared spectrophotometer is used. E. Mann

Coal Sampling Accuracy

Coryell, R. L. and Schwerd, F. J. TESTS OF ACCURACY OF SAMPLING MIXED COALS WITH SMALL INCREMENTS. *Combustion*, 27, 61-4 (1955) October; TESTS OF ACCURACY OF TOP SAMPLING OF RAILROAD CARS. *Combustion*, 27, 60-63 (1955) November; TESTS OF ACCURACY OF LABORATORY PREPARATION AND ANALYSIS OF COAL SAMPLES. *Combustion*, 27, 44-47 (1955) December.

For "commercial purpose" accuracy on mixed coals the ASTM requirements for lots under 1000 tons appear inadequate. It is indicated that either the minimum size of increments or the minimum number of increments should be increased. The second report covers the establishment of the variability of the eight coals received and the determination of the number and size of sample increments required to obtain ASTM accuracy of ± 10 percent of the ash content. The third report describes the tests made to determine the accuracy of the sample preparation and analysis, and compares the accuracies thus obtained with the results of other investigators. Authors' Abstract

Carbon Monoxide Methods

Beatty, R. L. METHODS FOR DETECTING AND DETERMINING CARBON MONOXIDE. U. S. Bur. Mines Bull. 557 (1955).

This publication discusses the various methods now used more or less generally for detecting and determining carbon monoxide in air and in other gaseous mixtures, outlining briefly the reactions or principles upon which the methods are based, the range of concentrations that may be determined, and the accuracy of determination. Other methods that are specialized in application or that have not received general use are discussed in less detail. References are given to pertinent original publications that describe the methods in greater detail. Methods for detecting and determining carbon monoxide that have been developed since this publication first was issued by the Bureau of Mines in 1938 have been included in this revision (of Technical Paper 582). Author's Abstract

Continuous Analyzer

Källe, K. T. GAS ANALYSIS APPARATUS. U. S. 2,719,425 (1955) October 4.

A gas analysis apparatus for continuous control of the amount of certain constituents in a gas mixture, e. g., the percentage of CO_2 in flue gases, is comprised of a gas purifier, a gas absorber connected to the purifier by a conduit having a restricted passage, a rotary pump, preferably a gear-pump, and a manometer connected to the suction conduit of the pump to indicate variations in pressure occurring in the system as a result of the removal of certain gas constituents in the absorber.

D. M. Mason

Evaporation Losses

Holowchak, J. and Baldeschwieler, E. L. LABORATORY METHODS FOR EVALUATION OF EVAPORATION LOSSES OF PETROLEUM PRODUCTS. *Anal. Chem.*, 27, 1941-47 (1955) December.

Two laboratory methods have been developed for the accurate determination of evaporation losses. The first procedure is a modified Chenicek-Whitman vapor pressure method, in which measured amounts of dry air are bubbled through a known amount of hydrocarbon mixture at a fixed temperature and at a rate to

ensure saturation of the air with hydrocarbon vapors. The vapor pressure of the hydrocarbon mixture is calculated from the volume of the vapor evolved, the total amount of air and vapor, and the pressure of the gas-evaporation curve is established to determine the effect of the evaporation loss on the density of the sample under investigation. Both procedures are accurate, convenient, and applicable to almost any type of evaporation problem. The vapor pressure method can accurately determine evaporation losses as low as 0.04%; density method can detect losses as low as 0.01%.

Authors' Abstract

Gas Industry Laboratories

Townsend, L. G. SOME ASPECTS OF SCIENTIFIC CONTROL IN THE GAS INDUSTRY. *Gas World* (British), 142 1226-34, 37 (1955) November 12; CHEMICAL LABORATORIES IN THE GAS INDUSTRY. *Gas J.* (British), 284, 522, 27, 28, November 23; 589-92 (1955) November 30.

Various features of the development and uses of chemical control of gas manufacture in the Liverpool area are discussed in detail. A central laboratory handles various tests required by the several works, which included coal and coke proximate, calorific value, new and old oxide tests, sample reduction and instrument maintenance. Special works problems and analyses, reports of technical results and information service also are handled here. Individual works laboratories are still needed, however, in the plant control of gas quality; tar, ammonia, and benzol recovery, sulfur removal; water softening effluents; purging, and general sampling. Personnel, research facilities and service problems are also discussed. O. P. Brysch

Gas Sampling

Geary, E. W. (assigned to Columbia-Southern Chemical Corp.) SAMPLING DEVICE. U. S. 2,725,951 (1955) December 6.

Means for purifying and feeding gas to a gas analyzer, and particularly for removing dust and corrosive acid gases, are described.

D. M. Mason

Källe, K. T. SAMPLING DEVICE FOR CONTINUOUS SUPPLY OF GAS. U. S. 2,719,432 (1955) October 4.

A sampling device for continuous supply of a substantially constant amount of gas per unit of time, particularly for supplying gas to an analyzer, is described. Blockage by dust of small orifices normally required to control gas flow is eliminated by a device comprised of two members, one of which rotates in contact with the other; holes in the two members are so arranged that flow of gas is intermittent in that channels communicate only during a small part of each revolution. D. M. Mason

Van der List, T. (assigned to Ruhrchemie A.-G.) GAS SAMPLING DEVICE. U. S. 2,726,548 (1955) December 13.

A gas sampling device is described which will continuously withdraw a small proportional amount of the gas flowing through a pipeline irrespective of pressure and velocity fluctuations, and which will not withdraw any gas when the flow stops or reverses.

D. J. Dennison

Laboratory Efficiency

Rothbard, D. COULD YOU USE A 50% INCREASE IN PRODUCTIVITY IN ROUTINE CONTROL LABORATORY OPERATION? *Petroleum Process.*, 10, 1914-18 (1955) December.

An efficiency-rating system used in a refinery laboratory is described. D. M. Mason

Metals in Oils

Horeczy, J. T., Hill, B. N., Walters, A. E., Schutze, H. G., and Bonner, W. H. DETERMINATION OF TRACE METALS IN OILS. Anal. Chem. 27, 1899-1903 (1955) December.

In the ashing of oils for the determination of trace metal contamination a modified wet ashing technique, compared to dry ashing, is shown to quantitatively retain volatile metallo-organic complexes of copper, iron, nickel, and vanadium.

R. R. Amrine

Vapor Chromatography

Podbielniak, W. J. and Preston, S. T. VAPOR-PHASE CHROMATOGRAPHY. *Petroleum Refiner*, 34, 165-69 (1955) November.

Principles, apparatus and techniques, applications, accuracy, and correlation with other analytical methods of this relatively new method of gas-vapor analysis are discussed.

D. M. Mason

8. GENERAL AND PHYSICAL CHEMISTRY

CO_2 Absorption

Goodridge, F. KINETIC STUDIES IN GAS-LIQUID SYSTEMS. PART II—INITIAL RATES OF CARBON DIOXIDE IN AMINE ASBORBENTS. *Faraday Soc. Trans.* (British), 51, 1703-09 (1955) December.

The results of a study of the rates of absorption of CO_2 in liquid amines and their aqueous solution during very short contact times. The variables investigated were concentration of absorbent, partial pressure of CO_2, configuration of the absorbent molecule and surface area of the liquid interface. R. F. Bukacek

Carbon Oxidation

Chen, M. C., Christensen, C. J. and Eyring, H. KINETICS OF THE OXIDATION OF PYROLYTIC CARBON. *J. Phys. Chem.*, 59, 1146-48 (1955) November.

The kinetics of carbon oxidation was studied by measuring the rate of decrease in the electrical conductivity of the carbon film as oxidation of the film progressed. For temperatures up to 550° C., an activation energy of 21 kcal. and an activation entropy of —28 e. u. were determined. The reaction was found to be first order with respect to oxygen pressure. A developed rate equation is presented.

E. J. Pyrcioch

Compressibility

Lindsey, D. H. SUPERCOMPRESSIBILITY MADE SIMPLE. *Pipe Line Ind.*, 3, 33-36 (1955) December.

Supercompressibility is a term seldom understood, yet it is of the utmost importance in high-pressure gas measurement. Here is a simple way to apply it. This is a must for every pipe line engineer's notebook.

Author's Abstract

Heat Capacity

Helefrey, P. F., Heiser, D. A., and Sage, B. H. ISOBARIC HEAT CAPACITIES AT BUBBLE POINT: TWO TRIMETHYLBENZENES AND n-HEPTANE. *Ind. Eng. Chem.*, 47, 2385-88 (1955) November.

This article reports the experimental data obtained for the isobaric heat capacity of three materials at temperatures from 80° F. to 220° F. B. E. Eakin

Equation of State

Christian, R. H. and Yarger, F. L. EQUATION OF STATE OF GASES BY SHOCK WAVE MEASUREMENTS. I. EXPERIMENTAL METHOD AND THE HUGONIOT OF ARGON. II. THE DISSOCIATION ENERGY OF NITROGEN. *J. Chem. Physics*, 23, 2042-49 (1955) November.

An experimental method is described for the simultaneous measurement of the velocity of a plane shock through a gas and the associated particle velocity. By use of this method, it has been determined that the dissociation energy of nitrogen is 9.764 ev., instead of the generally accepted lower spectroscopically determined value of 7.385 ev. B. E. Eakin

Oxygen-Nitrogen Equilibria

Armstrong, G. T., Goldstein, J. M., and Roberts, D. E. LIQUID-VAPOR PHASE EQUILIBRIUM IN SOLUTIONS OF OXYGEN AND NITROGEN AT PRESSURES BELOW ONE ATMOSPHERE. *J. Res. Nat. Bur. Standards*, 55, 265-277 (1955) November.

A circulating low-temperature vapor liquid phase-equilibrium apparatus is described in which data on the oxygen-nitrogen system were obtained. Data were obtained over a range of compositions at each of three temperatures; 77.5; 70°, and 65° Kelvin. A table is presented, and various of the physical properties calculated from these measurements.

B. E. Eakin

Polymer Film Permeability

Waack, R., Alex, N. H., Frisch, H. L., Stannett, V., and Szwarc, M. PERMEABILITY OF POLYMER FILMS TO GASES AND VAPORS. *Ind. Eng. Chem.*, 47, 2524-27 (1955) December.

The permeabilities of a number of polymer films to oxygen, nitrogen, carbon dioxide, methyl bromide, and ethylene oxide have been measured using high-vacuum technique. The effect of temperature, pressure, and film thickness on the permeability constant has also been investigated. The permeation of gases and vapors

through polymer films appears to be diffusion-controlled. The permeability constants for any gas vary enormously with the nature of the polymers. G. G. Wilson

Pore Volume

Benesi, H. A., Bonnar, R. U., and Lee, C. F. DETERMINATION OF PORE VOLUME OF SOLID CATALYSTS. *Anal. Chem.*, 27, 1963-65 (1955) December.

A convenient method has been devised for the measurement of the micropore volume of porous solids at room temperature. It consists of weighing the carbon tetra-chloride adsorbed by catalyst samples after equilibrium with a solution in which the vapor pressure of carbon tetrachloride had been lowered 5% through cetane addition. The above type of pore volume measurement was found to be just as reliable and much more convenient than that consisting of the measurement of adsorbed nitrogen at —196° C. Authors' Abstract

Surface Tension

Barnett, M. K. and Orban, E. APPARATUS FOR THE STUDY OF THE EFFECT OF DISSOLVED GASES ON THE SURFACE TENSION OF LIQUIDS AT ELEVATED TEMPERATURES AND PRESSURES. *Producers Monthly*, 20, 22-25 (1955) November.

This paper describes apparatus constructed for the purpose of measuring the surface tension of liquids while saturated with oxygen at elevated temperatures and pressures. Tests on water reproduced existing literature data.
B. E. Eakin

Viscometer

Maron, S. H. and Belner, R. J. LOW SHEAR CAPILLARY VISCOMETER WITH CONTINUOUSLY VARYING PRESSURE HEAD. *J. Appl. Physics*, 26, 1457-60 (1955) December.

A capillary viscometer is described for the study of the flow behavior of non-Newtonian fluids at shear stresses of 0.06 to 20 dynes/cm^2. The measurements are made under unsteady-state conditions. The data and methods presented show the operation and results with the instrument for determining viscosities of Newtonian liquids and flow curves of non-Newtonian fluids.
B. E. Eakin

9. ORGANIC CHEMISTRY

Chemical Raw Materials

McKetta, J. J. and Ponder, T. C. RAW MATERIALS TODAY. *Petroleum Refiner*, 34, 116-19 (1955) December.

The present place and future outlook for the major raw materials for petrochemical production are reviewed. Although natural gas and LP-gas will probably remain the chief sources, significant gains in this field are expected for refinery off-gases and residual fuel oils. Total hydrocarbon consumption for petrochemical production is expected to represent about 1.3 per cent of total refinery production by 1960.
J. M. Reid

HCN Synthesis

Radke, H. H. and Kotheimer, C. H. (assigned to The B. F. Goodrich Co.) PRODUCTION OF HYDROGEN CYANIDE. U. S. 2,726,733 (1955) December 13.

In the synthesis of hydrogen cyanide from methane and ammonia, loss by polymer formation and separate ammonia recovery is achieved by passing the product gases through towers packed with granular acidic silica gel. The ammonia-free gas is then scrubbed with water to recover pure HCN. The tower packing after saturation is regenerated by passage of air at 175°-200° C. which is scrubbed with water to remove ammonia and the solution stripped of ammonia to be returned to the process.
O. P. Brysch

10. CHEMICAL ENGINEERING

Adsorption

Zankey, H. E. (assigned to W. E. Moore and Co.) APPARATUS FOR THE TREATMENT OF GASES. U. S. 2,727,585 (1955) December 20.

The construction of an adsorption apparatus is described. The solid adsorbent is held in horizontal bags in such a manner as to ensure uniorm bed depth and prevent channelling. Regenerative means are also provided.
W. G. Bair

Contact-Tray Design

Katzen, R. HELP IN PICKING THE RIGHT TRAY. *Chem. Eng.*, 62, 209-12 (1955) November.

Cost and performance data on five different tray

types for distillation or absorption towers are presented. The discussion includes various design factors important to tray selection.

R. F. Bukacek

Fractionation

Acrivos, A. and Amundson, N. R. ON THE STEADY STATE FRACTIONATION OF MULTI-COMPONENT AND COMPLEX MIXTURES IN AN IDEAL CASCADE. PART VI —THE EFFECT OF VARIATIONS OF THE RELATIVE VOLATILITIES, THE FLOW RATES AND THE PLATE EFFICIENCIES. *Chem. Eng. Science*, **4**, 249-54 (1955) December.

An approximate yet standard procedure, the perturbation method, is used to solve analytically the equation for the steady state fractionation of multicomponent and complex mixtures in non-ideal cascades. It is shown that the formulae are easily adaptable to numerical evaluation. The perturbation method is particularly useful when the calculations for a system which is close to ideal must be made. The perturbation method may be considered as a non-ideality superimposed on the ideal solution. The ideal solution may be thought of as the first approximation to the solution while the perturbation is the second approximation. Higher order approximations are difficult to carry out. [*See also Gas Abs* **12**, 19 (1956) January.]

Authors' Abstract

Heat Exchangers

Donohue, D. A. HEAT EXCHANGER DESIGN. PART III: FLUID FLOW AND THERMAL DESIGN. *Petroleum Ref.* **34**, 175-85 (1955) November.

Part 3 of a series of 4 on heat exchanger design, this paper presents equations and various nomographs for calculating pressure drop across exchangers.

R. F. Bukacek

Heat Transfer

Deissler, R. G. TURBULENT HEAT TRANSFER AND FRICTION IN THE ENTRANCE REGIONS OF SMOOTH PASSAGES. *Amer. Soc. Mech. Eng. Trans.*, **77**, 1221-33 (1955) November.

This paper gives the results of an analytic investigation of the effect of various factors on the turbulent heat transfer and friction in the entrance region of smooth passages. The influence of Reynolds number, Prandtl number, initial velocity distribution, well boundary condition, passage shape and of variable fluid properties is predicted.

R. F. Bukacek

Kays, W. M. NUMERICAL SOLUTIONS FOR LAMINAR-FLOW HEAT TRANSFER IN CIRCULAR TUBES. *Amer. Soc. Mech. Eng. Trans.*, **77**, 1265-74 (1955) November.

Numerical solutions are presented for a number of heating conditions for the case where the Prandtl number is 0.7.

R. F. Bukacek

Mass Transfer

Gambill, W. R. TO ESTIMATE MASS-TRANSFER FACTORS. *Chem. Eng.*, **62**, 207-10 (1955) December.

A method is outlined for estimating the Schmidt number for any particular system. Three different types of problems are calculated to illustrate the technique.

B. E. Eakin

Piping of Slurries

Spells, K. E. CORRELATIONS FOR USE IN TRANSPORT OF AQUEOUS SUSPENSIONS OF FINE SOLIDS THROUGH PIPES. *Instn. Chem. Engrs. Trans.*, (British), **33**, 79-84 (1955).

Results of experiments on the flow through pipes of slurries consisting of mixtures of fine solid particles with water have been collected from the literature. In most cases the pipes were horizontal, but a few authors included vertical sections in their pipelines. The slurries considered (called "settling slurries") can only be transported in turbulent flow; moreover the rate of flow must exceed a certain "minimum velocity" depending on the physical properties of the slurry if clogging by deposition of the solid component on the pipe bottom is to be avoided. Until the flow rate attains a certain "standard velocity," however, the pipe friction pressure losses exceed those for an "equivalent true fluid" of density equal to that of the slurry and viscosity equal to that of the medium (water); above the standard velocity the pressure losses are similar to those with the equivalent true fluid. In the present paper dimensional analysis has been applied to obtain rough correlations for both the minimum and standard velocities in terms of particle size, particle (material density, fluid density, slurry density, and pipe diameter.

Author's Abstract

Thermal Failure

Bergman, D. J. EQUIPMENT FAILURE DUE TO HEAT. *Petroleum Processing*, 10, 1729-35 (1955) November.

An analysis of six common thermal failures caused by temperature gradient stresses.

W. G. Bair

Water Supply

Gilliland, E. R. FRESH WATER FOR THE FUTURE. *Ind. Eng. Chem.*, 47, 2410-22 (1955) December.

The total fresh water supply (3 to 5 feet of rainfall for world land area) is many times greater than present or foreseeable needs, but the difficulty is that rain does not always fall when and where it is needed. Recent noticeable shortages are due to distribution deficiencies in equipment and inadequate local sources. Costs of current supplies and of processing from sea water are discussed in much detail. Processes treated include: distillation (single and multi-effect, compression solar and ocean), critical pressure, freezing, extraction osmosis, ion exchange and electrodialysis. O. P. Brysch

11. PROCESS EQUIPMENT AND INSTRUMENTATION

Computers

DeCarlo, C. R. THE FUTURE OF AUTOMATIC INFORMATION HANDLING IN CHEMICAL ENGINEERING. *Chem. Eng. Progress*, 51, 487-91 (1955) November.

A general discussion of the application of automatic electronic computers in the following five areas: 1) fundamental research; 2) chemical engineering design; 3) economic studies of process operations; 4) production management; and 5) automation. S. Hu

Equipment Hazards

Goldsmith, L. M. WHEN IS AN AREA HAZARDOUS? *Oil Gas J.*, 54, 152-58 (1955) November 21.

A general discussion of the use of electrical equipment in petroleum refineries. The API recently produced RP-500 which is very useful in classifying refinery areas for hazards.

W. G. Bair

Liquid Flowmeter

Kritz, J. ULTRASONIC FLOWMETER. *Instr. and Autom.*, 28, 1912-13 (1955) November.

A flow meter based on the generation of ultrasonic pressure waves is described. The meter appears to have application to hydrocarbon liquid but not to gases. R. F. Bukacek

Power Plant

Archbold, M. J. COMMONWEALTH EDISON COMPANY INSTALLS THIRD UNIT AT STATE LINE. *Combustion*, 27, 49-57 (1955) December.

State Line Station provides an unusual opportunity to make a comparison of three large steam turbine units which were placed in operation in 1929, 1937 and 1955. Sargent and Lundy acted as consulting engineers for Unit No. 3, as well as for Unit No. 1 and Unit No. 2. The author points out special features of mechanical design and pays a tribute to the designers of Unit No. 1 which in 1954, after a quarter century of reliable service, turned in an average heat rate performance which was better than the originally expected plant heat rate. Unit No. 3 installed in 1955 is a General Electric 3600-1800-rpm cross-compound, double-flow, 2000-psig, 1050-F primary and 1050-F reheat turbine rated at 221,469-kw at 1 in back pressure. It is connected to two hydrogen-cooled, 15,500-v, three-phase generators totaling 217,647 kva at ½-psig and 272,058 kva at 30-psig hydrogen pressure. Unit No. 3 is served by a 1,350,000-lb-per-hr Combustion Engineering pulverized-coal-fired, controlled-circulation, dry-bottom, twin-furnace boiler, using eight Raymond bowl mills, three Ljungstrom air heaters, and a Research Corp. mechanical-electrostatic dust collector. Author's Abstract

Solids Feeder

Bell, G. R. METER DRY MATERIAL AS ACCURATELY AS LIQUID. *Chem. Processing*, 18, 14-15 (1955) November.

A feeding system consisting of a hopper with a vibrator and a variable screw has been used successfully in delivering a diatomaceous silica filter aid at rates of 25 to 500 grams per min. with an error of less than $\pm 1\%$.

E. J. Pyrcioch

12. MATERIALS OF CONSTRUCTION

Aluminum Corrosion

Godard, H. P. THE CORROSION BEHAVIOR OF ALUMINUM. *Corrosion*, **11**, 542t-52 (1955) December.

The practical corrosion behavior of aluminum is reviewed for the non-specialist. Included is a discussion of the following topics: the relative nature of corrosion resistance, resistance criteria, factors influencing corrosion rates, common corrosion problems, how to choose an alloy; and galvanic, deposition, crevice and pitting corrosion. Specific information is given on corrosion in six major environments. Other topics considered include corrosion of brazed and welded joints, atmospheric performance of anodized aluminum and preventive measures. Twenty-nine references are appended for persons interested in further study. Author's Abstract

Ceramics

Mitchell, L. CERAMICS. *Ind. Eng. Chem.*, Part II, 47, 1956-62 (1955) September.

The author presents the IEC Chemical Engineering Review of some of the recent developments in ceramics. These are grouped under fundamental research; special fittings, coatings and cermets; dielectrics and non-silicate bodies; enamels; whitewares; structural clay; and materials and equipment, with citation of 85 references. S. Volchko

Coatings

Gibbon, A. NEW WAY TO STOP CORROSION. *World Oil*, **141**, 200 (1955) November.

A spray method of coating steel with lead is a recent innovation in the fight against corrosion. No heat is needed in the application of finely-divided lead. It is sprayed on by means of a volatile wetting agent. It has been proven successful on tubing, tanks handling sour crude, water disposal equipment, heater-treaters, etc. Author's Abstract

Ravald, L. A. PROTECTION OF STRUCTURAL STEEL—THE PRESERVATION OF STEEL ON GAS WORKS (GREAT BRITAIN). *Chem. and Ind.* (British), No. 48, 1526-34 (1955) November 26.

A review of the procedures and material used to preserve steel gas works structures. The topics discussed include methods of removing rust and mill scale, the use of metallized steel, and protective coatings. Methods of solving several specific gas plant corrosion problems are also presented. G. G. Wilson

Corrosion

Akimov, G. W. ELECTRODE POTENTIALS. PART II OF 2 PARTS. *Corrosion*, **11**, 515t-34 (1955) December.

A relatively detailed discussion of the electrode potentials of active cathodes and anodes, of complex electrodes, of electrodes composed of solid solutions, and of intermetallic compounds. This discussion is well illustrated with schematic diagrams, and documented with tabulated results of numerous experimental determinations of electrode potentials in a variety of typical electrolyes. [See *Gas Abs.* **12**, 38 (1956) February.] G. G. Wilson

Henke, R. W. CORROSION: HOW IT AFFECTS MATERIALS SELECTION AND DESIGN. *Materials and Methods*, **42**, 119-34 (1955) November.

Corrosion is briefly defined and methods of expressing rates of corrosion are outlined. Types and mechanisms of corrosion are briefly discussed and illustrated including galvanic corrosion, corrosion caused by chemical action, dezincification, graphitization, caustic embrittlement, hydrogen embrittlement, intergranular corrosion, stress corrosion cracking, corrosion fatigue and fretting and cavitation corrosion. Design procedures that should be followed to avoid stress corrosion, direct chemical attack and galvanic corrosion are briefly outlined to illustrate the way in which corrosion can be reduced by proper design. A rating chart for the corrosion resistance of 29 different plastic, rubber and metal construction materials to a wide variety of chemical environments commonly encountered in industry is included. G. G. Wilson

Inhibitors

CORROSION INHIBITORS IN PETROLEUM REFINERY SERVICE. *Corrosion Techn.* (British), **2**, 343-47 (1955) November.

After a brief outline of the principle of passivation mechanics whereby the three major categories of inhibitors prevent corrosion is discussed and illustrated by examples of their use in preventing corrosion of petroleum refinery equipment. G. G. Wilson

Special Refractories

Read, H. L., Roe, F. C., Schroeder, H. S. and Wroten, W. L. NEW USES FOR SUPERREFRACTORIES IN THE CHEMICAL INDUSTRY. *Ind. Eng. Chem.*, 47, 2513-16 (1955) December.

Superrefractories include ceramic and self-bounded, kiln-fired products, made from silicon carbide, pured alumina, and electric furnace mullite, as well as electrically poured, cast refractory materials. In addition to being suitable for temperature service in the range 1500-1700° C., these refractories also possess properties of high thermal conductivity, resistance to thermal shock, corrosion resistance, high strength, and abrasion or erosion resistance. Of these, silicon carbide is the most versatile and widely used. Its newer applications have been for lining cooling or scrubbing chambers, spray nozzles, burner tips for acid sludge, venturi meter or feeders, agitator or mixer blades, pumps, diffusers and cyclone collector linings.

E. J. Pyrcioch

Whittemore, O. J., Jr. SPECIAL REFRACTORIES FOR USE ABOVE 1700° C. *Ind. Eng. Chem.*, 47, 2510-12 (1955) December.

The pure oxide refractories which have become available commercially in the post-war period include alumina, magnesia and stabilized zirconia. Alumina is characterized by its excellent stability and lower cost. Magnesia has high electrical resistivity, slag resistance, and a high melting point of 2800° C. Stabilized zirconia also has a high melting point, 2650° C. and a very low thermal conductivity. Used in smaller quantities are such refractories as lime, thoria, urania, beryllia and spinel. Of the non-oxides, silicon carbide with its high oxidation resistance, shock resistance, and lower cost is the most important. Properties, applications and limitations of the refractories are discussed.

E. J. Pyrcioch

Welding

WHY THE API RETURNED TO THE 30° BEVEL. *Gas*, 108-13 (1955) November.

This report abstracts the studies of the relative merits of a 30° *vs* a 37½° bevel angle for electric welding of pipe sponsored by the Northern Natural Gas Company at the University of Omaha.

G. G. Wilson

13. NEW BOOKS

(C. A. Simms, Librarian)

Organic Chemistry

Cook, J. W., "Progress in Organic Chemistry." Vols. 2 and 3. New York: Academic Press, 1953-55.

A continuation of a work begun in 1952. The articles are concise, but accompanied by extensive bibliographies. This is an up-to-date review which will be of great value to the research worker.

Mass Transfer

AIChE, "Mass Transfer — Transport Properties." New York: The Institute, 1955. Number 16 in the AIChE Symposium series.

A collection of papers including, "Viscosity of Gases and Gas Mixtures at High Pressures," by N. L. Carr, J. D. Parent and R. E. Peck. This paper covers work done at the Institute of Gas Technology and presents methods for the prediction of the viscosity of gases and gas mixtures over the practical range of pressure, temperature and phase composition encountered in moderate and super-pressure operations.

Combustion

AGARD "Combustion Researches and Reviews, 1955" and "Spontaneous Ignition of Liquid Fuels." London: Butterworth, 1955.

Two monographs on combustion. The first is a collection of papers presented at the 6th and 7th Combustion Panel meetings and deal mainly with flame stabilization and spray formation and combustion. The second is essentially a review in one area of combustion, but is also a sourcebook of experimental information on spontaneous ignition published during the present century.

Hydrocarbon Properties

Sage, B. H. and Lacey, W. N., "Some Properties of the Lighter Hydrocarbons, Hydrogen Sulfide, and Carbon Dioxide." New York: American Petroleum Institute, 1955.

A companion volume to their earlier publication, "Thermodynamic Properties of the Lighter Paraffin Hydrocarbons and Nitrogen."

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Australian Journal of Applied Science
Australian Journal of Chemistry

Bituminous Coal Research Reports
Brennstoff-Chemie
British Coal Utilization Research Association Monthly Bulletin and Quarterly Gazette
Butane-Propane News

California Oil World
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Canadian Journal of Chemistry
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Industrial Finishing
Industrial Gas (American)
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Institute of Fuel (British). Journal
Institute of Gas Technology Publications
Institute of Petroleum (British). Journal
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National Fire Protection Association Quarterly
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INTERCHANGEABILITY OF HIGH-BTU OIL GASES AND NATURAL GASES

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